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March 10, 1995

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Mr. William F. Caton
Acting Secretary
Federal Communications Commission
1919 M Street, NW, Room 222
Washington, DC 20554

FEDERAL COMMUNICATIONS COMMISSION
ACTING SECRETARY

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Re: Ex Parte Presentation
ET Docket No. 94-124

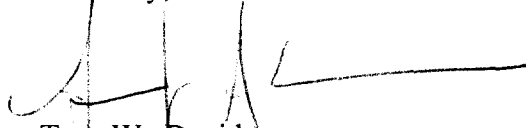
Dear Mr. Caton:

On behalf of Teledesic Corporation ("Teledesic"), we are enclosing herewith for filing MPT 1550, Issue 1, "Performance Specification for Analogue Multipoint Video Distribution Systems (MVDS) Transmitters and Transmit Antennas Operating in the Frequency Band 40.5 - 42.5" (Sept. 1993), and Phillips Microwave, "Microwave Video Distribution Systems - The 1994 Position," (Dec. 1994), as an ex parte presentation in the above-captioned proceeding. These documents were cited to as references in Teledesic's engineering analysis, "Apples-to-Apples Comparison Demonstrates the Feasibility of LMDS Above 40 GHz", attached as Appendix A to its Reply Comments in the above-captioned proceeding. The materials are being filed in order to provide additional engineering support to Teledesic's showing that LMDS in the 41 GHz band is technically and economically comparable to LMDS in the 28 GHz band.

Pursuant to Section 1.1206 of the Commission's Rules, an original and one copy of this letter and its associated attachments are being filed with the FCC's Office of the Secretary.

Correspondence or inquiries concerning this matter should be directed to the undersigned.

Sincerely,



Tom W. Davidson
Jennifer A. Manner

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Enclosures

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MPT 1550

ISSUE 1

Performance Specification

Performance Specification for
Analogue
Multipoint Video Distribution
Systems (MVDS) Transmitters
and Transmit Antennas Operating
in the Frequency Band
40.5 - 42.5 GHz

SEPTEMBER 1993

Foreword

1 It is required by the Wireless Telegraphy Act, 1949 (as modified by the Post Office Act, 1969) that no radio apparatus shall be installed or used in the United Kingdom except under the authority of a licence granted by the Secretary of State. It is a condition of such a licence that the performance of the apparatus must meet certain minimum standards.

2 The minimum standards of performance are given in specifications prepared by the Radiocommunications Agency, in consultation with the relevant manufacturers and operators.

For convenience, to avoid the need to test every piece of equipment, manufacturers are invited to make representative production models of their equipment available for testing by or under the control of the Agency.

Manufacturers or their specified agents who wish to submit MVDS transmitters and transmit antennas for type approval testing should apply to:

Radiocommunications Agency
Television Broadcasting Section
Room 318
Waterloo Bridge House
Waterloo Road
London SE1 8UA
Telephone 071-215-2132

3 The application should state when and where the tests can be carried out and should be accompanied by a description of the apparatus, including drawings and test results obtained in the manner described in the appropriate performance specification.

It should also list all type numbers that may apply to non-technical variants of the model submitted.

Radiocommunications Agency reserves the right to give separate type approval to models it considers to be technical variants and whose performance may differ as between types. If the Agency considers that the difference between technical variants is minor, it may agree to a reduced number of tests being performed on these variants.

4 A charge is made for type approval testing to recover the Agency's costs incurred in performing such work. Details of current charges are available from the address above. Manufacturers are invoiced on completion of a type approval test and the type approval certificate is provided by the Agency on receipt of payment.

5 Equipment will also be considered for approval purposes either:

- a) by direct compliance with MPT 1550; or
- b) by compliance with any national standard or government regulation of any Member State of the European Communities; or
- c) by compliance with any relevant international standard or regulation recognised in a Member State of the European Communities;
- d) and where appropriate, compliance with manufacturing rules and procedures of any Member State relating to quality control operations during manufacture of the equipment where they form part of a standard or technical regulations in a) to c) above;

provided that in case b) or c) the regulation is deemed to comply with MPT 1550

The results of tests to such a standard will be taken into consideration if carried out by authorised and accredited test houses in accordance with ISO 25, EN 45001 or a National standard confirming these requirements.

6 Performance specifications may be subject to amendment. Intending manufacturers should ensure they possess the latest copy of the relevant specification.

7 This performance specification is written for licensing purposes and does not take into consideration the requirements of the EMC directive 89/336/EEC, as amended by directive 92/31/EEC. The EMC directive has been implemented in the UK by Statutory Instrument 1992 No.2372 "The Electromagnetic Compatibility Regulations". For compliance, the MVDS transmission equipment will need to be tested to additional specifications covering EMC parameters. It will become mandatory from 1st January 1996 for the issue of an EC type examination certificate from a Notified Body before the equipment can be placed on the market or brought into service in the EC. The Radiocommunications Agency is the notified body for such equipment in the UK.

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PART 1

STANDARD REQUIREMENTS

Requirements common to all equipment

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1 GENERAL

1.1 Scope of Specification

This specification covers the minimum mandatory requirements of transmitters and transmit antennas for use in Analogue¹ Multipoint Video Distribution Systems in the frequency band 40.5 GHz to 42.5 GHz. Frequency modulation techniques of either I/PAL or D2-MAC signal formats shall be employed, which are compatible with the limits for radiated spectrum defined within this document.

Details of the minimum performance requirements of MVDS transmitters are contained in Part 2 and antennas in Part 3 of this Specification.

The performance of receiver outdoor and indoor units specified in Annex 1 is given for information only. The local oscillator and channel plan are given in Annex 2.

¹ The use of digital modulation is not precluded from the band 40.5 - 42.5 GHz but will be subject to further consideration by the RA.

1.2 Operating Frequencies

The equipment shall provide transmissions in the frequency band 40.5 GHz to 42.5 GHz. The precise operating frequencies shall be quoted by the Secretary of State when a licence is issued. For the purpose of type testing, the equipment may be submitted on a mutually agreed channel or channels in the above frequency band. The need to test more than one channel will depend on any technical differences between channels which might alter the interference causing potential of the channel. Such differences might include (but are not restricted to):

- i) the use of different types of filter for different channels.
- ii) down-conversion of a sample of the transmitter output for frequency control using different local oscillator frequencies for different channels.

1.3 Controls

Where the equipment incorporates controls, which if maladjusted might cause the equipment to interfere with other equipment or radio services, they shall not be accessible or operable without the use of a tool or tools.

1.4 Declarations

When submitting an item for type approval, the manufacturer shall supply the following:-

- (a) i) Nominal frequency range of the transmitter.
- ii) For non-synthesised equipment, carrier reference frequencies and carrier generation formulas.
- iii) For equipment which is synthesised or includes closed loop frequency control, the frequencies of any local oscillators which are used to down-convert a sample of the transmitter output.

- (b) Number of transmitter channels.
- (c) Rated radio frequency output power per channel at the radio frequency output port.
- (d) Baseband video input format (e.g. I/PAL and/or D2-MAC).
- (e)
 - i) Sub-carrier frequencies, where applicable.
 - ii) Peak to peak deviation of the main carrier by unmodulated sub-carrier, when applicable.
- (f) Nominal supply type and voltage
- (g) The manufacturer shall declare the maximum normal signal levels, impedance and return loss at each input port of the transmitter.
- (h) The manufacturer shall declare any technical differences in the design of different channels which might give rise to differences in their interfering-causing potential (see section 1.2).

1.5 Labelling

The equipment shall be provided with a clear indication of the type number and description under which it is submitted for type testing. Each number shall be unique and in the case where the testing authority finds two manufacturers have used a similar type number, one manufacturer shall be asked to change the type number.

Type approved equipment shall be permanently marked with an approved label which shall be located on the outside of the equipment and be immediately visible. The minimum dimensions of the label shall be 10 x 15 mm. The location of the label shall be agreed between the manufacturer and the testing authority and shall be recorded in the test report.

The label used to indicate transmitter compliance shall be as shown in Figure 1.1.

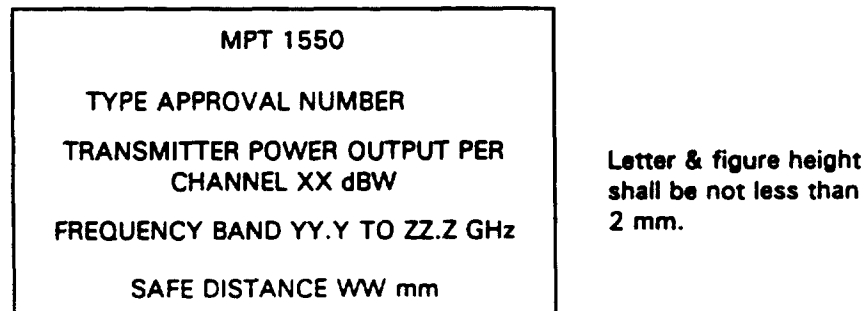
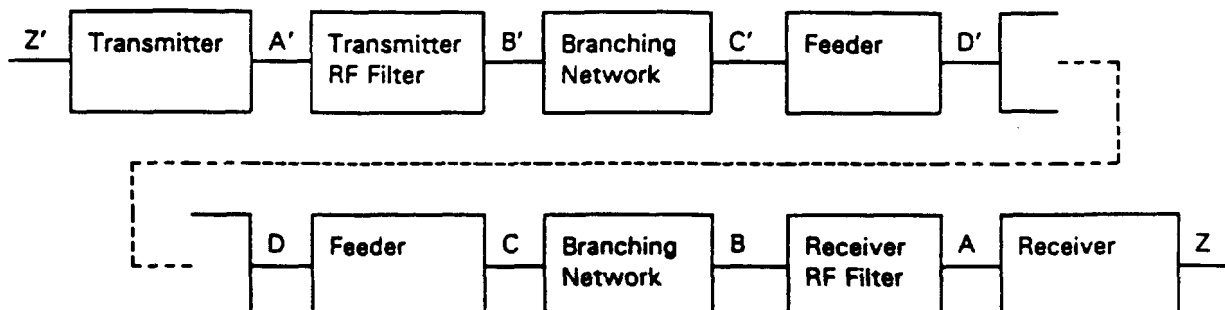


FIGURE 1.1

1.6 Input and Output Port - Definitions

- 1.6.1 For the purpose of the specification the terms "transmitter input port", "receiver input port", "transmitter output port" and "receiver output port" shall be taken to refer to those points corresponding respectively to the ports Z', C, C' and Z in Figure 1.2. Points Z' and Z are baseband input and output points respectively.

1.6.2 Accessibility for measuring R.F. power is referred to in Section 2.1.



Note: For the purpose of defining the measurement points, the branching network does not include a hybrid.

FIGURE 1.2 RF BLOCK DIAGRAM

1.7 PLL Systems

Where phase-lock-loops (PLL) systems are used for carrier generation, precautions shall be taken to ensure that any lack of synchronisation does not cause deviation outside the permitted frequency limits specified on the type approval certificate.

1.8 Quality of Service and Availability Criteria

The overall requirement is to provide a typical grade of service of CCIR Grade 4 for all but 1% of the worst month.

2 TEST CONDITIONS: ATMOSPHERIC CONDITIONS AND POWER SUPPLIES

2.1 General

Type approval tests shall be made under normal test conditions (Section 2.3) and also, where stated, under extreme test conditions (Section 2.4).

Where the equipment is intended to be part of an integral radio equipment and antenna configuration, the radio equipment submitted for the test shall be identical to that employed in the integral arrangement except that it is separated from the antenna and fitted with a suitable waveguide flange or connector to form a test interface. Connection to this test interface will allow equipment performance to be measured.

Each channel group variant shall be submitted for approval.

Alternative measurement methods for the testing of integral equipment without separating the radio equipment from the antenna may be proposed. Full details of the method and limits together with supporting technical evidence shall be given in writing to the type approval authority at least four weeks prior to the tests. The use of such methods and limits are subject to the agreement of the type approval authority.

2.2 Test Power Source

During type approval tests, the power supply for the equipment may be replaced by a test power source, capable of producing normal and extreme test voltages as specified in Clauses 2.3.2 and 2.4.2.

The internal impedance of the test power source shall be low enough for its effects on the test results to be negligible. For the purpose of type approval tests, the supply voltage shall be measured at the input terminals of the equipment. If the equipment is provided with a permanently connected power cable, the test voltage shall be measured at the point of connection of the power cable to the equipment.

During the tests the power source voltage shall be maintained within a tolerance of $\pm 3\%$ relative to the voltage at the beginning of each test. In equipment in which batteries are incorporated, the test power source shall be applied as close to the battery terminals as practicable.

2.3 Normal Temperature Conditions

2.3.1 Normal Temperature and Humidity

The normal temperature and humidity conditions for tests shall be any convenient and naturally occurring combination of temperature and humidity within the ranges:-

Temperature $+15^{\circ}\text{C}$ to 35°C
Rel. Humidity 20% to 75%

Note: When it is impracticable to carry out the tests under the conditions stated above, a note stating the actual temperature and relative humidity during the tests shall be added to the test report.

2.3.2 Normal Test Source Voltage

2.3.2.1 Mains Voltage

The normal test source voltage for equipment to be connected to the mains shall be the nominal voltage. For the purpose of this specification the nominal voltage shall be any of the declared voltages for which the equipment is designed. The frequency of the test source corresponding to the AC mains shall be between 49 and 51 Hz.

2.3.2.2 Float Battery Power Sources

When the radio equipment is intended for operation from a float battery, the normal test source voltage shall be the typical float voltage of the battery.

2.3.2.3 Other Power Sources

For operation from other power sources or types of battery, either primary or secondary, the normal test source voltage shall be that declared by the manufacturer.

2.4 Extreme test conditions

2.4.1 Extreme temperature and humidity

For test purposes the equipment shall be required to meet the relevant environmental conditions set below:

a) Indoor equipment

Temperature +5°C to +40°C
Relative humidity 5% to 85%

b) Outdoor equipment

Temperature -20°C to +40°C
Relative humidity 5% to 100%

2.4.2 Extreme Test Source Voltages

2.4.2.1 Mains Voltage

The extreme test source voltages for equipment to be connected to an AC mains source shall be the nominal mains voltage $\pm 10\%$. The frequency of the test source shall be between 49 and 51 Hz.

2.4.2.2 Battery Power Sources

When the equipment is intended for operation from the usual type of regulated lead-acid battery the extreme test voltage shall be 1.3 and 0.9 times the nominal voltage of the battery specified for the equipment.

2.5 Procedure for Tests at Extreme Temperatures

2.5.1 General

Before making measurements, the equipment shall be placed in a temperature controlled chamber for a period of one hour or for such a period as may be judged necessary for thermal balance to be obtained. The equipment shall be switched off during the temperature stabilisation period. During these tests at extreme temperatures the humidity content in the test chamber shall be controlled so that it lies within the ranges given in clause 2.4.1.

2.5.2 Test Procedure

For tests at the upper and lower temperatures, after thermal balance has been attained (Clause 2.5.1), the equipment shall be switched on in the transmit condition for half an hour, after which the appropriate tests shall be carried out.

3 INTERPRETATION OF THIS SPECIFICATION

In the event of doubt arising over the interpretation of this specification, or the method of conducting the tests, the decision of the Testing Authority shall be final.

4 ACCURACY OF MEASUREMENT

The tolerance for measurement of the quantities shown below will be as indicated.

4.1	DC Voltage	$\pm 3\%$
4.2	AC Mains Voltage	$\pm 3\%$
4.3	AC Mains Frequency	$\pm 0.5\%$
4.4	Radio Frequency	± 2.5 ppm (± 100 kHz @40 GHz)
4.5	Radio Frequency Power	± 1 dB
4.6	Impedance of artificial loads, combining units, plugs, attenuators	$\pm 5\%$
4.7	Source Impedance of generators	$\pm 10\%$
4.8	Attenuation of attenuators	± 1 dB
4.9	Temperature	$\pm 1^{\circ}\text{C}$
4.10	Humidity	$\pm 5\%$

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PART 2

TRANSMITTER SPECIFICATION

Specification for

Analogue

Multipoint Video Distribution System

**(MVDS) transmitters operating in the
frequency band 40.5 GHz to 42.5 GHz**

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1 GENERAL CONDITIONS

1.1 Carrier frequency relationship between channels

The frequency relationship between channel carriers must at all times be constant, as given in the MVDS channel plan of Annex 2 to this specification.

1.2 Transmission channel capacity

The transmission path shall be capable of accepting baseband video input signals of I/PAL and/or D2-MAC transmission standards.

In the case of I/PAL, the signal may have wideband and narrowband frequency modulated sound subcarriers associated with it.

1.3 Transmitter artificial load

Tests on the transmitter shall be carried out using a non-reactive non-radiating load connected to the transmitter radio frequency output port. The load shall have a return loss of not less than 26 dB.

1.4 Frequency deviation

1.4.1 Primary video signal

The primary video signal may be defined as that traffic not carried on a sub carrier. The frequency deviation of the primary traffic shall be limited to a level that will ensure that the spectral power density shown in figure 2.1 is not exceeded when the carrier is modulated with the relevant standard test signals as given in paragraphs 1.6.3 and 1.6.4. Primary video deviation for I/PAL should not exceed 16 MHz/V, whereas for D2-MAC the complete baseband signal is frequency modulated giving a deviation of 13.5 MHz/V. Note that the mask also contains the maximum allowable centre frequency tolerance and must be taken into consideration when setting the deviation.

1.4.2 Pre-emphasis

The pre-emphasis added to the baseband video modulating signal should be of a recognised standard to ensure compatibility with standard indoor receiving units to be used for MVDS.

1.4.3 Subcarrier deviation of the main carrier

For the I/PAL standard, the maximum deviation of the main carrier by any additional subcarriers shall not cause the overall spectral power density given in 1.4.1 to be exceeded.

1.5 Standard baseband test signals

The standard I/PAL baseband test signal shall comprise a video baseband signal together with audio sub-carriers appropriate to give maximum spectrum width.

A standard D2-MAC test signal incorporating up to 8 audio channels in the baseband shall be used.

1.5.1 Signal levels

The level of the test signals applied to the transmitter input ports shall correspond to the maximum level experienced under normal operation. Video signal levels shall be the peak to peak voltage of the luminance signal at the transmitter input port expressed in volts. Audio signal levels shall be the rms voltage of the audio signal at the transmitter input port expressed in dB relative to 775 mV (0 dBm in 600 Ω). For high impedance unbalanced inputs this shall be expressed in mV.

In the case of composite video inputs being provided at the transmitter, only those baseband parameters given in 1.6.1 and 1.6.3 below are applicable.

The manufacturer shall declare the maximum normal signal levels, impedance and return loss at each transmitter input port.

1.6 Baseband parameters

1.6.1 Video interfaces

Level:	Nominally 1V peak-to-peak
Impedance:	75 Ω unbalanced
Minimum return loss:	26 dB

1.6.2 Audio interfaces (if applicable)

Balanced (symmetric) or high impedance unbalanced.

The audio signal used for tests shall be a sinusoidal tone at the maximum normal signal level declared by the manufacturer.

1.6.3 Video baseband test signals

Standard video baseband signals are as follows:

- (a) I/PAL broadcast colour television.
100% colour bars.
- (b) D2-MAC standard EBU colour bars.

1.6.4 Sub-carrier test signals for I/PAL (if applicable)

The standard sub-carrier audio input test signals are as follows:

- (a) Narrowband audio 6 kHz
- (b) Wideband audio 15 kHz

2 TRANSMITTER

2.1 Frequency error

2.1.1 Definition

The frequency error of each transmitted carrier is the difference between the measured carrier frequency and its nominal value.

2.1.2 Method of measurement

- (a) The transmitter shall be operated in accordance with the manufacturer's instructions and its output shall be connected to an artificial load (Clause 1.3) .
- (b) The emission shall be monitored by a frequency counter and the carrier frequency shall be measured in the absence of modulation. In cases where the transmitter's design does not allow for frequency control in the absence of modulation, the manufacturer must satisfy the testing authority that the limit for carrier frequency error is met.
- (c) The measurement shall be made under normal test conditions (Part 1, Clause 2.3.1 and 2.3.2) and repeated under extreme test conditions (Part 1, Clauses 2.4.1 and 2.4.2 applied simultaneously).

2.1.3 Limits

The frequency error of each carrier, under both normal and extreme test conditions shall not exceed:

$$\pm 12.5 \text{ ppm } (\pm 0.5 \text{ MHz @ } 40 \text{ GHz})$$

The nominal frequency relationship (channel spacing) between carriers must at all times be constant at 29.5 MHz \pm 1.0 MHz, as given in the MVDS channel plan of Annex 2 to this specification.

2.2 Carrier power

2.2.1 Definition

The carrier power of a transmitter is the average power supplied to the antenna transmission line by a transmitter during one radio frequency cycle taken under conditions of no modulation. Carrier power is limited to a nominal 200mW (-7 dBW).

2.2.2 Method of measurement

- (a) The transmitter output port (point C' on the Block Diagram) shall be connected to an artificial load (Clause 1.3) with means of measuring the power delivered to this load.
- (b) In the absence of modulation, the transmitter shall be operated in accordance with the manufacturer's instructions. The carrier power shall be set to the manufacturer's rated output.
- (c) The measurement shall be made under normal test conditions (Part 1, Clause 2.3) and repeated under extreme test conditions (Part 1, Clauses 2.4.1 and 2.4.2 applied simultaneously).

2.2.3 Limits

The carrier output power under normal and extreme test conditions shall not exceed the manufacturers rated output power by more than 2dB. For power exceeding 200mW, further consideration will need to be given by the Radiocommunications Agency.

2.3 Spurious emissions

2.3.1 Definition

Spurious emissions are emissions on a frequency or frequencies which are outside the necessary bandwidth of the required transmission side bands and the level of which may be reduced without affecting the corresponding transmission of information.

Spurious emissions include harmonic emissions, parasitic emissions, intermodulation products as a result of multi-channel operation and frequency conversion products but exclude emissions on frequencies immediately outside the necessary bandwidth which result from the modulation process.

The effects of intermodulation products of multi-channel systems are under consideration.

2.3.2 Method of measurement

- (a) The transmitter output port (point C' on the Block Diagram) shall be connected to either a spectrum analyzer via an attenuator, or an artificial load with some means of monitoring the emission with a spectrum analyzer or selective voltmeter. The transmitter carrier shall be unmodulated. The measurement bandwidth shall be agreed with the Type Approval Authority.

- (b) Frequencies below waveguide cut-off

For equipments using waveguide at the transmitter output interface with the antenna, frequencies below the waveguide cut-off frequency will be greatly attenuated. Therefore for frequencies of less than half the waveguide cut-off frequency, subject to the presence of a length of waveguide of at least two cut-off wavelengths long, measurements of spurious emissions are not required. This will be subject to manufacturing drawings being presented which show that the design incorporates the cut-off attenuation described.

- (c) Frequencies above waveguide cut-off

Compliance with spurious emissions may be demonstrated by measuring total power in a given calibrated band. The limit on total power should not exceed the limit for any single spurious product as defined in 2.3.1.

For example spurious products in the 80 GHz to 90 GHz band would be measured using power measurement equipment with WR-10/WG-27 waveguide hardware. Within this band, the total power would be limited to -50 dBW which is the limit for single spurious products in the 80 - 90 GHz band.

- (d) With the exception of frequencies not individually swept (i.e. due to waveguide above and below cut-off) and excluding frequencies within the necessary bandwidth, for each spurious emission detected over the frequency range, the level of the emission shall be measured.

2.3.3 Limits

The power of any spurious emission shall not exceed -80 dBW within the frequency range 42.5 GHz to 43.5 GHz, to protect the Radio Astronomy Service. Spurious emissions outside the above frequency range shall not exceed the following absolute values:

30 MHz to 21.2 GHz	: -90 dBW
21.2 GHz to 80 GHz	: -60 dBW
80 GHz to 90 GHz	: -50 dBW

2.4 Radiated spectrum

2.4.1 Definition

The radiated spectrum is that resulting from the modulation process and includes emissions both within and outside the necessary bandwidth.

2.4.2 Method of measurement

- (a) The transmitter output port (point C' on the Block Diagram) shall be connected to either a spectrum analyzer via an attenuator, or an artificial load with some means of monitoring the emissions with a spectrum analyzer. The spectrum analyzer shall have a variable persistence display or digital storage display and its controls shall be adjusted as in Table 2.1.

Control	Setting
RF centre frequency	Transmitter carrier frequency
IF bandwidth	3 kHz
Total sweep width	80 MHz
Amplitude scale	Logarithmic 10 dB/div
Video filter	3 kHz
Total scan time	≥ 15s

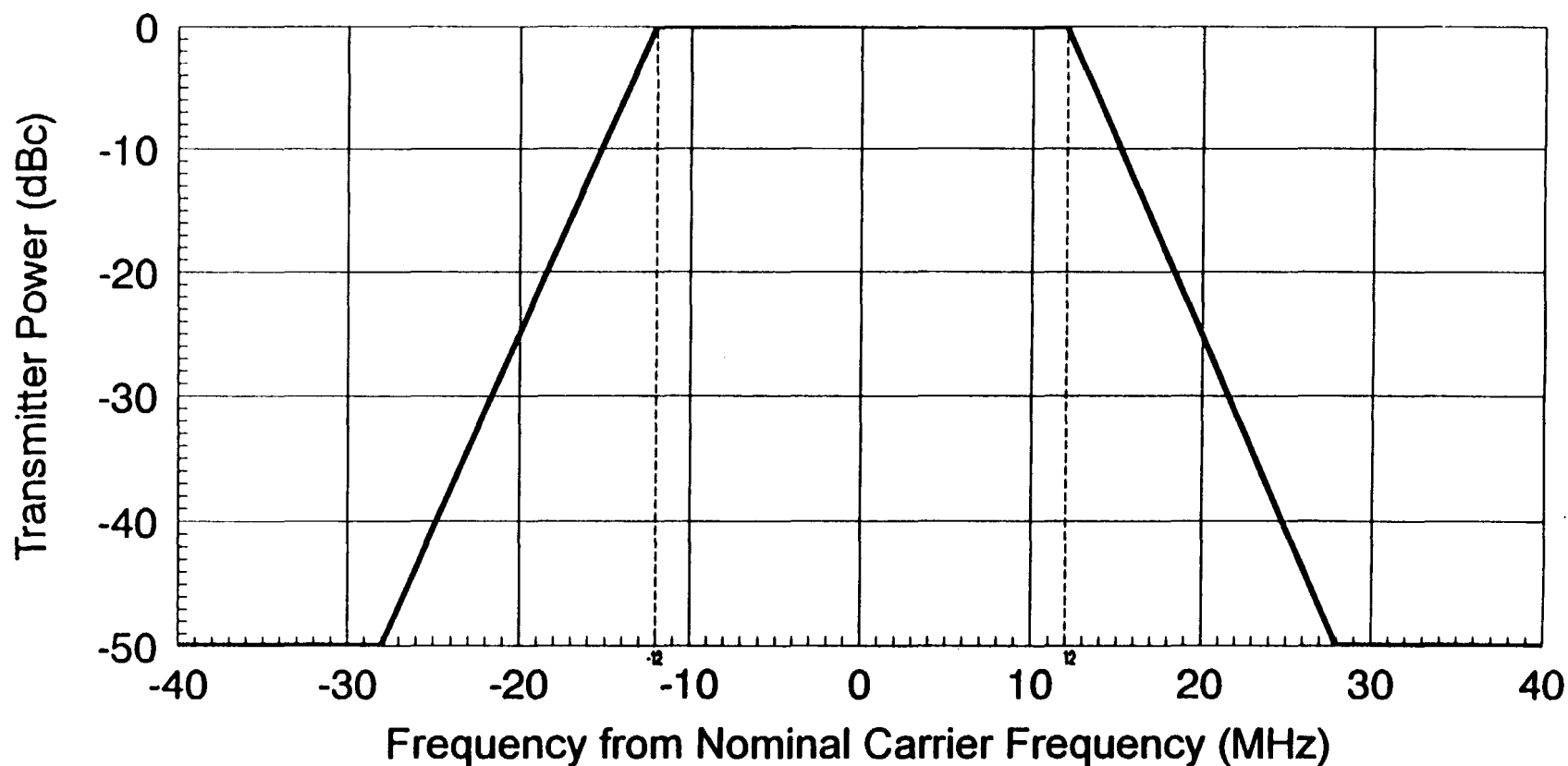
Table 2.1 Spectrum Analyzer Settings

- (b) The unmodulated transmitter carrier shall be observed and its amplitude on the display screen set to a convenient datum level by the adjustment of the spectrum analyzer attenuator controls. In cases where the transmitter design does not allow for frequency control in the absence of modulation, the method of setting the datum level shall be agreed with the Type Approval Authority.
- (c) The transmitter shall be modulated by a composite signal having the characteristics indicated in Clauses 1.6.3 and 1.6.4 and the spectrum analyzer display shall be recorded.

2.4.3 Limits

The transmitter radiated spectrum under the specified conditions of modulation shall be such that no component shall have a level greater than that indicated in Figure 2.1. This Figure includes an allowance for frequency tolerance.

Fig 2.1 Limits of Spectral Power Density for I/PAL & D2-MAC Video Basebands
 Referred to Nominal Channel Frequency (f_0)
 0 dB Represents the unmodulated carrier



(Mask includes an allowance for Frequency Tolerance)

NOTE: The transmitter output spectrum must be within these limits when modulated with the video test signals as defined in Part 2 Section 1.6.3

2.5 SUMMARY OF TRANSMITTER PARAMETERS

Frequency band of operation	40.5 GHz to 42.5 GHz
Frequency of transmission (unmodulated)	See Annex 2 Channel Plan
Transmitter output power per channel	≤ 200 mW (≤ -7 dBW)
Frequency stability of transmission (unmodulated)	± 0.5 MHz of nominal centre frequency
Spurious emissions outside the band 42.5 - 43.5 GHz	30 MHz to 21.2 GHz < -90 dBW 21.2 GHz to 80 GHz < -60 dBW 80 GHz to 90 GHz < -50 dBW
Spurious emissions within the band 42.5 - 43.5 GHz	< -80 dBW
Spectral power density referred to nominal carrier frequency	See Fig 2.1
Modulation Mode	Frequency Modulation
Modulation system	CCIR system I/PAL or D2-MAC
Nominal channel spacing	29.5 MHz

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PART 3

**Transmit Antennas for Analogue Multipoint Video
Distribution System Operating in
the Frequency Band 40.5 GHz to 42.5 GHz.**

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